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Animal Investigation Program (AIP) A.I.P. Summary Report On and Around The Nevada Test Site From 1982 - 1995

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Animal Investigation Program (AIP) A.I.P. Summary Report On and Around The Nevada Test Site From 1982 - 1995

by

Kenneth R. Giles

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RADIATION AND INDOOR ENVIRONMENTS NATIONAL LABORATORY
OFFICE OF RADIATION AND INDOOR AIR
U.S. ENVIRONMENTAL PROTECTION AGENCY
P.O. BOX 98517
LAS VEGAS, NV 89193-8517

NOTICE

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Abstract

This report describes the Animal Investigation Program conducted from 1982 - 1995 by the Environmental Protection Agency's (EPA's), Radiation and Indoor Environments National Laboratory (R&IE), formerly Radiation Sciences Laboratory-Las Vegas. This laboratory operates an environmental radiation monitoring program in the region surrounding the Nevada Test Site. The surveillance program was designed to measure levels and trends of radionuclides in animals on and around the Nevada Test Site to ascertain whether world-wide fallout, current radiation levels, and associated doses, to the general public were in compliance with existing radiation protection standards. The surveillance program additionally had the responsibility to take action to protect the health and well-being of the public in the event of any accidental release of radioactive contaminants.

Comparison of the measurements and sample analysis results indicated that no significant amounts of biological radionuclides had been detected in the near offsite areas or on the NTS, except in animals drinking water that drains from tunnels in Area 12.

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Abreviations and Acronyms

ACE	-	U.S. Atomic Energy Commission
AIP	-	Animal Investigation Program
EMSL-LV	-	Environmental Monitoring Systems Laboratory-Las Vegas
EPA	-	U.S. Environmental Protection Agency
MDC	-	minimum detectable concentration
NTS	-	Nevada Test Site
QA	-	quality assurance
QC	-	quality control
R&IE	-	Radiation and Indoor Environments National Laboratory

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Introduction

In November 1955, the U.S. Atomic Energy Commission (AEC) established a program to investigate claims of injury to domestic animals alleged to be caused by nuclear tests at the Nevada Proving Grounds. The Nevada Proving Grounds was renamed the Nevada Test Site (NTS) and the original program was expanded to develop the Animal Investigation Program (AIP).

The AIP began in 1957 (Ref. BER-6) with the purchase of a herd of beef cattle which were allowed to graze on the NTS. This herd was maintained on the NTS until 1981. In the fall of 1981 the herd was rounded up and transferred to the University of Nevada in Reno, Nevada. This terminated a 25-year study of a single herd which had lived in an area contaminated by nuclear testing activities. The animal-sampling portion of the AIP was continued through 1995 with the semiannual sampling from commercial beef herds, quarterly sampling of the NTS deer herd, annual sampling of the bighorn sheep, and annual sampling of food crops grown on farms and ranches adjacent to the NTS. Veterinarian services was provided by the U.S. Army from 1955 to 1964 until being assigned to the U.S. Public Health Service. The U.S. Public Health Service provided veterinarian services until the program was terminated in 1995.

Sample Collection Procedures

Beginning in 1982 cattle were purchased from the ranchers that lived in close proximity to the Nevada Test Site (NTS). Each spring and fall, four beef animals were selected that lived in open range areas for most of their lives. These animals were transported by the Environmental Protection Agency from the Farm Facility to Area 15, where they were necropsied.

Each necropsied animal was sampled for radionuclides in muscle, lung, liver, bone, blood, kidney, thyroid and fetus if available. Each animal was also given an examination for gross pathological condition. Samples for histopathology studies included adrenal glands, eye, heart, kidney, lung, muscle, liver, spleen, gonads, thyroids, and any gross lesions found.

Mule deer (Odocoileus hemionus) were collected on a quarterly basis on the NTS. They were generally collected in the Pahute Mesa, Rainier Mesa area in the summer and from the areas on the south of these mesas in the winter. For locations, see Figure 1 (for past migration patterns Ref. EPA 600/4-85-030). The same type samples were taken on the mule deer and the same analysis performed as on the cattle. During 1993 - 1994 one mule deer a year was collected offsite in Nye County near Adaven, NV to be used as a control.

Bighorn sheep were collected by licensed hunters with the cooperation of the Nevada Department of Wildlife. For locations, see Figure 2. Sample kits were provided to hunters during annual hunter indoctrination classes. Hunters were asked to provide age, location, and date of the kill. Also, they were asked to provide hock bone and kidneys for radionuclide analysis. Bighorn sheep sampling was discontinued in 1993 due to lack of hunter response and budgetary constraints.

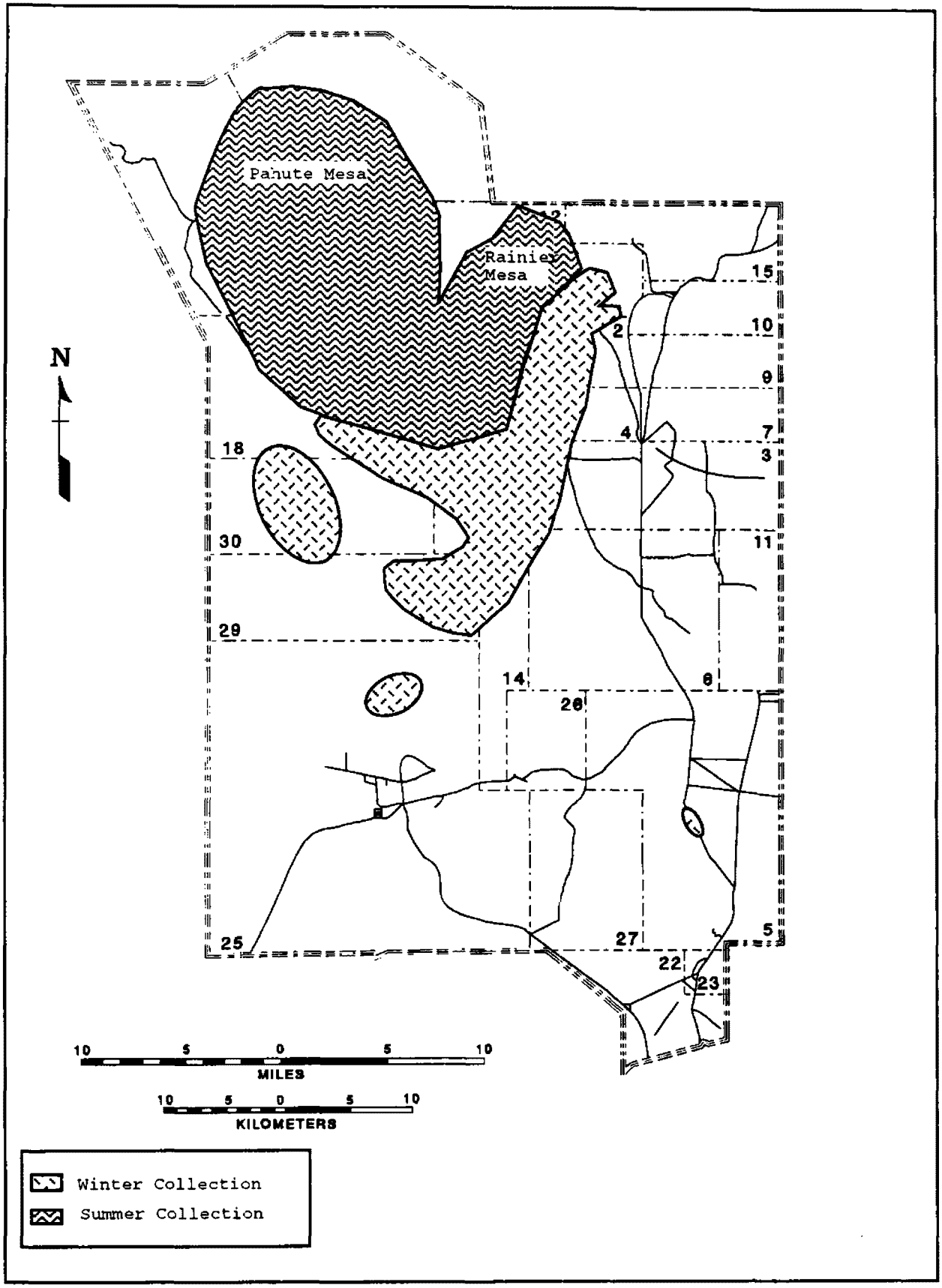

Figure 1 Locations of summer and winter collection of mule deer.

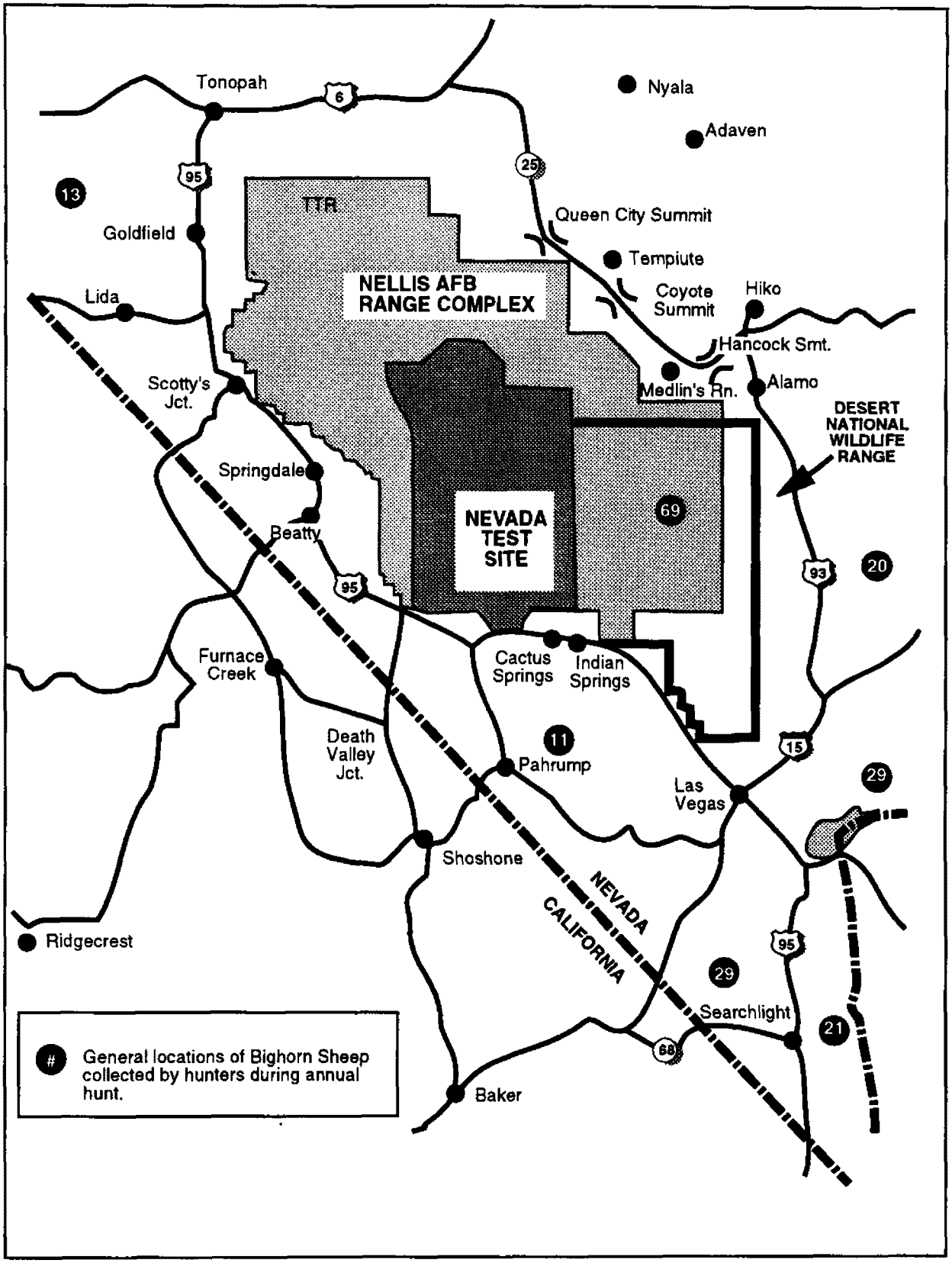

Figure 2 Total number of bighorn sheep collected during annual hunt from 1981 - 1992.

Quality Assurance/Quality Control (QA/QC)

Standard operating procedures detailed sample collection, preparation, storage, analysis, and data review procedures to ensure comparability among operators. Field personnel completed a standardized necropsy protocol form to ensure that all relevant information was recorded, such as date and location of collection, history and condition of the animals and tissues, sample weights, and assigned identification numbers. Standardized forms accompanied each shipment of samples sent to the contract laboratory for ashing and were also used for analyses conducted in the Radioanalysis Laboratory. All information entered into the data base management system by Sample Control and the radioanalysis chemists were checked and verified for analytical precision and accuracy by the Group Leader and assigned media expert.

An estimate of system precision was obtained from results of duplicate samples. Matrix spike samples were used to verify analytical accuracy. Matrix blank samples monitored any contamination resulting from sample preparation and analysis. The entire sample set analyzed in any given year was quite small (usually four or five sample batches) and, consequently, the QA/QC sample result set contained fewer values than was considered minimal for statistical uses. Therefore, the results of QA/QC samples were considered to provide only an indication or estimate of true precision and accuracy. This was considered adequate because the Animal Investigation Program itself was not statistically based.

Before 1991, analyses of animal tissue samples were performed by a contract laboratory. The EPA Environmental Monitoring Systems Laboratory-LV, Radioanalysis Branch assumed responsibility for sample analysis beginning with the results contained in this report. The change of laboratories raised concerns about comparability of analyses, so a special QA review was conducted. The procedures used by each laboratory were comparable, as were results of matrix spike samples. Generally, the result ranges obtained in 1991 were similar to those obtained in previous years when samples were analyzed by the contract laboratory. Finally, results of QA/QC samples, with the exception of one routine duplicate pair, were within established control limits. Although a direct comparability study was not undertaken (i.e., analysis of replicate samples by both laboratories), the results of the QA review indicated the data obtained for 1992 analyses were comparable to data obtained in previous years (EPA 1990, EPA 1991, and EPA 1992).

The QA review also resulted in recommendations for some changes in the animal investigation program that were implemented in 1992. These recommendations included preparation of a large stock of matrix spike and blank sample material and addition of a system blank. The single stock of matrix spike sample material permited an additional estimate of precision, in this case analytical precision, to be obtained. The system blank was a bone sample known to contain no detectable concentrations of radionuclides (with the possible exception of strontium). It was processed with each tissue sample batch to provide a check of possible contamination during the ashing and sample preparation processes.

Special Sampling

Following the Mighty Oak Test (April 1986), mule deer were collected that had been drinking water draining from the T-tunnel complex in Area 12 on the NTS. A total of three deer were collected (on June 17, September 9, and October 23, 1986). A wide variety of fresh fission products (^{131}I, ^{103}Ru, ^{106}Ru, ^{95}Zr, ^{3}H and ^{89}Sr) were detected in the soft tissue and ingesta samples. Iodine-131 was still detectable in the thyroid of deer collected on September 9, 1986, 152 days after the nuclear detonation. The results are shown in Appendix A. Appendix C lists the Announced United States Nuclear Tests conducted at the NTS during the period covered by this report.

During June 1987, one horse was sampled in Area 18 at the NTS. This animal had an ocular squama cell carcinoma that involved the entire left side of the head. Muscle and bone samples were taken for radioanalysis. Only naturally occurring ^{40}K was detected in the muscle. Radionuclide concentrations of $^{239+240}Pu$ in ashed bone were 0.013 ± 0.005 pCi/g ash and radionuclide concentrations of ^{90}Sr in ashed bone were 5.0 ± 0.17 pCi/g ash.

A female mountain lion (Felis concolor) that had been menacing Area 12 personnel on the NTS was killed by an authorized NTS hunter in the spring of 1991. The lion was in extremely poor physical condition. The animal appeared to have been starved into a very weakened condition. The necropsy revealed no injury or physical problems. Gamma analyses were performed on samples taken from the mountain lion's kidney, lung, muscle, blood, and liver. The analyses on these samples found only naturally occurring ^{40}K. Tritium analysis on the animal's blood resulted in $71,300 \pm 400$ pCi/L - indicating she drank from the Area 12 ponds. Plutonium and Strontium analyses were performed on ashed bone samples. Muscle and bone samples were ashed and analyzed for plutonium isotopes; the bone sample was also analyzed for ^{90}Sr in bone, with a result of 1.09 ± 0.07 pCi/g ash, and $^{239+240}Pu$ in muscle, with a result of 0.018 ± 0.009 pCi/g ash. For mountain lion sighting see Appendix B, Figure 1.

During the summer of 1993, a request was made by the Nevada Department of Wildlife personnel to trap chukar (Alectoris chukar) on the NTS. Several chukar's were collected in areas adjacent to T-tunnel, Tub Spring, Tippipah Spring and Tonopah Spring. In addition, one quail was collected at White Rock Spring. Gamma, tritium and plutonium and strontium analyses were performed on the chukars. The gamma analyses found naturally occurring ^{40}K and ^{137}Cs. The ^{137}Cs was found in the Tippipah Spring chukar(s) at 0.030 ± 0.009 pCi/g and in the Tub Spring chukar(s) at 0.19 ± 0.02 pCi/g. Tritium was detected in chukar samples collected near T-tunnel and Tub Spring. Tritium results ranged from 0.61 to 38,700 pCi/L in internal organs and 1.33 to 32,800 pCi/L in muscle. Plutonium and strontium analyses were performed on bone samples of three of the chukars collected at Tippipah Spring. The $^{239+240}Pu$ results on these bone samples ranged from 8.7 to 490 pCi/g ashed bone and the ^{90}Sr results ranged from 0.24 to 3.5 pCi/g ashed bone.

In 1994, two chukars were collected in Esmeralda County by Nevada Department of Wildlife personnel. The chukar were used as controls for the NTS chukar sampling. Only naturally occurring ^{40}K was found in the muscle. No tritium was detected in the muscle above the MDC

(450 x 10^{-4} pCi/mL). No strontium was found in the bone ash above the MDC (^{89}Sr .25 pCi/g and ^{90}Sr .37 pCi/g). The one bone sample with plutonium slightly above the MDC (^{238,239,240}Pu .008 - .02 pCi/g) was 3.5 pCi/g ash of $^{239+240}$Pu. See Appendix A Table 3, for ^{90}Sr concentrations for miscellaneous wildlife on the NTS.

During the summer of 1994, an aged Hereford bull was killed in Area 18. This was the last surviving animal from the original NTS beef herd and had spent his entire life on the NTS (14 plus-years). This animal had a squamous cell carcinoma that had spread to both his kidneys and lungs. Only naturally occurring ^{40}K was detected in soft tissue samples. Some $^{239+240}$Pu was detected in the liver, lungs, rumen content, and bone which ranged from 0.018 ± 0.06 pCi/g ash with the median of 0.023 pCi/g ash. The bone contained 1.42 ± 0.446 pCi/g of ^{90}Sr per gram ashed and 0.019 ± 0.007 pCi/g of ^{238}Pu per gram of rumen content ash.

Histopathology

From 1981 through 1995 all beef animals and mule deer were necropsied and tissue samples were collected. Histopathology revealed no significant lesions in the mule deer tissue on the NTS. In addition, there were only an occasional ocular squamous cell carcinoma found in beef cattle tissue. This squamous cell carcinoma is commonly found in cattle breeds with white hair and poorly pigmented skin around the mucous membranes of the eye (Ref. *Merck vet. Manual 7th Edition*).

Claims Investigation

The history of the Animal Investigation Program (AIP) has been well documented (Ref. Smith, Black 1957 - 1981). From 1981 - 1996 the AIP received no requests for investigation of alleged damage to domestic or wild animals in the NTS area.

Summary

During the 14-year period covered in this report the AIP sampled various commercial beef herds, mule deer, and bighorn sheep, that existed adjacent to the NTS (see Figure 3).

Out of a possible 388 soft tissue samples from cattle lung, liver, muscle, and rumen content, only 14 samples were above the MDC of 1.27 ± 10^{-2} pCi/g for ^{137}Cs. The samples ranged from 14.0 to 30 pCi/g wet weight. The results from mule deer were in the same range as the beef cattle for ^{137}Cs with the exception of animals collected near T-tunnel in Area 12. Radionuclide values for these animals are shown in Appendix A.

Cesium-137 was found in the kidney samples of bighorn sheep. Of the 195 samples collected, five had values greater than MDC (1.27 ± 10^{-2} pCi/g), ranging from 23 pCi/g to 97 pCi/g wet weight. A special effort was made to sample mule deer around T- tunnel in Area 12. The results of that sampling are shown in Appendix A.

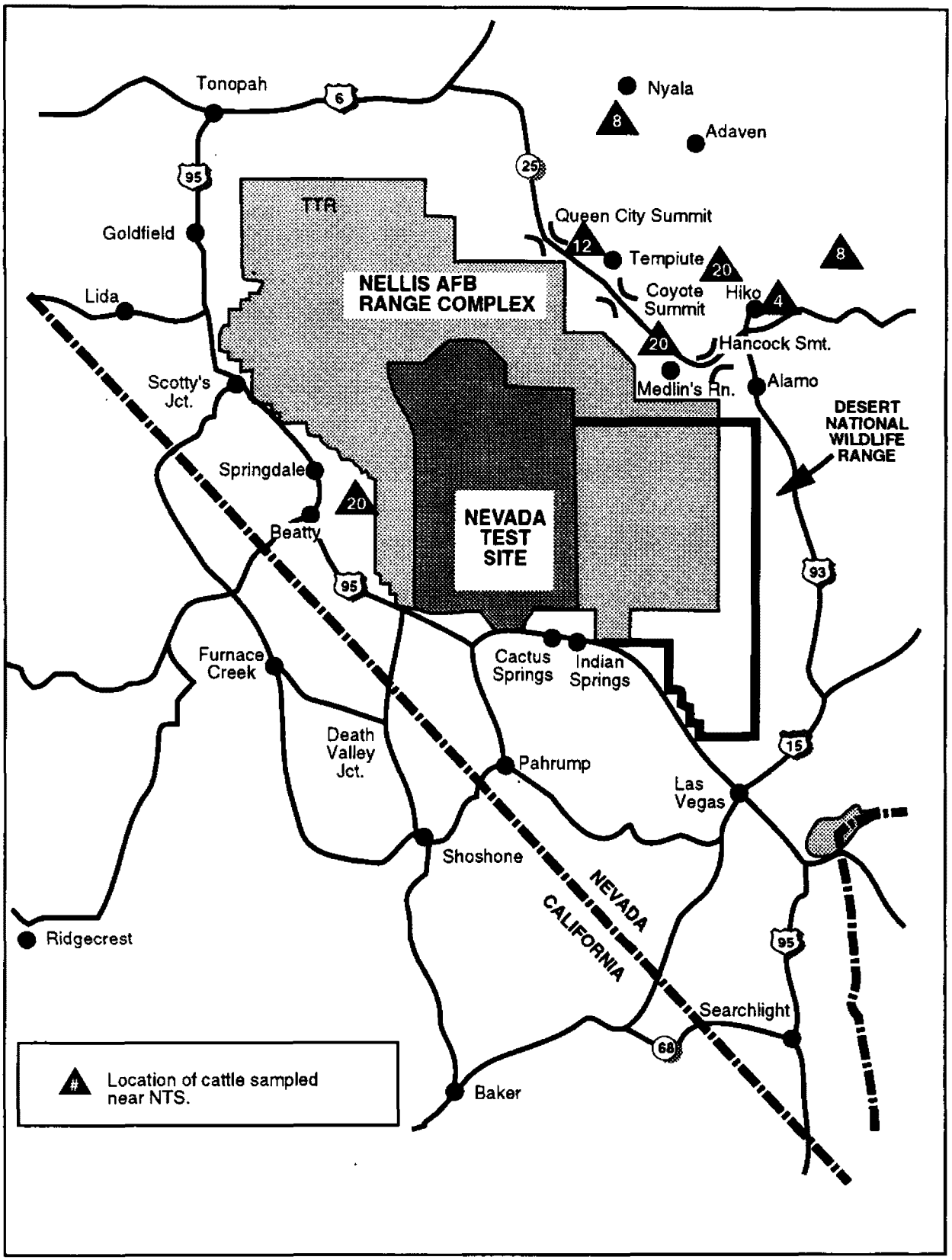

Figure 3 Locations of cattle sampled near the NTS.

Strontium-90 in bone ash of all species sampled follows a similar decline, and levels appear to follow worldwide fallout; results are shown in Appendix A. The graphs in Appendix B shows the decline in ^{90}Sr from 1963 to 1995.

Tritium concentration in beef cattle and wildlife were within the range present in the general environment. Mule deer and chukar exposed to specific sources of tritium, (e.g., the ponds near T-tunnel in Area 12) had elevated concentrations as expected. See Appendix B, Figure 5 for tritium levels in mule deer.

Iodine-131 was detected in four beef cattle from the Rachel, Nevada area following the Chernobyl accident and thought to be associated with worldwide fallout from the accident. Iodine-131 concentrations in the thyroid ranged from 1.5 to 27 pCi/g. Iodine-131was detected in the thyroid of mule deer collected at T- tunnel during 1989 and their concentrations ranged from 12 to 2.0 x 10^6 pCi/g.

Several ad hoc studies were conducted at the NTS, e.g., horse, chukar, and mountain lion sampling. The surveillance conducted at the NTS since 1982 suggested no significant amounts of radionuclides in biota have been detected in the near offsite areas or on the NTS except in animals drinking water from ponds near Area 12 tunnels.

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Appendix A

Table 1. Radionuclide concentration from Mule Deer collected at T-tunnel.

Tissue	^{131}I pCi/g	^{103}Ru pCi/g	^{137}Cs pCi/g	^{106}Ru pCi/g	^{3}H µCi/L[a]	^{239}Pu µCi/g/ash	^{238}Pu µCi/g/ash	^{90}Sr pCi/g/ash	^{89}Sr pCi/g/ash
Mule Deer No. 1 Collected June 17, 1986									
Thyroid	$2.0 \times 10^{6} \pm 3.2 \times 10^{2}$								
Kidney	110 ± 0.4	9 ± 0.09	0.8 ± 0.04		130 ± 0.3				
Liver	80 ± 0.3	2.6 ± 0.05	0.4 ± 0.3						
Lung	90 ± 0.5	0.5 ± 0.05	0.3 ± 0.04			.024 ± .007			
Muscle	16 ± 0.2	0.4 ± 0.03	0.2 ± 0.03						
Blood	90 ± 0.4	0.1 ± 0.02	0.05 ± 0.01		150 ± 0.3	.006 ± .002			
Rumen[b] Contents	110 ± 4.7	8 ± 0.3	0.2 ± 0.03	1.2 ± 0.4		.036 ± .007	.009 ± .003		
Bone								2.8 ± 0.1	
Mule Deer No. 2 Collected September 9, 1986									
Thyroid	5300 ± 19	ND		ND					
Kidney[d]	0.18 ± 0.04	1.8 ± 0.04	0.09 ± 0.02	0.9 ± 0.1					
Muscle[c]	ND	0.3 ± 0.02	0.2 ± 0.02	0.2 ± 0.08	100 ± 0.2				
Liver	0.4 ± 0.04	0.9 ± 0.03	0.05 ± 0.003						
Lung	0.04 ± 0.02	0.08 ± 0.01	0.02 ± 0.007						
Rumen[c] Contents	0.1 ± 0.03	0.7 ± 0.02	0.03 ± 0.01	0.4 ± 0.09	90 ± 0.2				
Bone								1 ± 0.4	21 ± 0.3

Note: All data in the tables are reported in 2 sigma data.

Table 1. Radionuclide concentration from Mule Deer collected at T-tunnel (Cont'd)

Tissue	^{131}I pCi/g	^{103}Ru pCi/g	^{137}Cs pCi/g	^{106}Ru pCi/g	^{3}H µCi/L[a]	^{239}Pu µCi/g/ash	^{238}Pu µCi/g/ash	^{90}Sr pCi/g/ash	^{89}Sr pCi/g/ash
Mule Deer No. 3 Collected October 23, 1986									
Thyroid	Gamma Spectrum Negligible								
Kidney	Gamma Spectrum Negligible				0.0009 ± 0.00006				
Liver	Gamma Spectrum Negligible								
Lung	Gamma Spectrum Negligible								
Muscle	Gamma Spectrum Negligible								
Blood	Gamma Spectrum Negligible								
Rumen[b] Contents	Gamma Spectrum Negligible								
Bone							.0055 ± .004	.006 ± .001	
Mule Deer No. 4 Collected October 29, 1986									
Thyroid	12 ± 1								
Kidney[d]	Gamma Spectrum Negligible								
Muscle[e]	0.1 ± 0.06	0.1 ± 0.03							
Liver[g]	0.7 ± 0.1	0.04 ± 0.02	1.0 ± 0.3						
Lung	0.3 ± 0.1	0.06 ± 0.04							
Rumen[h] Contents	0.06 ± 0.007	0.7 ± 0.03	<0.4						
Blood					180 ± 0.3				
Bone							.0044 ± .0041	1.2 ± 0.4	16 ± 1.8

Continued

a Aqueous portion of tissue sampled.
b Rumen contents from Mule deer 1 also contained ^{95}Zr (3.6 ± 0.1 pCi/g) and ^{95}Nb (0.14 ± 0.03 pCi/g).
c Rumen contents from Mule deer 2 contained ^{22}Na (0.03 ± 0.01).
d Kidney contents from Mule deer 2 also contained ^{203}Hg (0.09 ± 0.02 pCi/g) and ^{22}Na (0.03 ± 0.02 pCi/g).
e Muscle contents from Mule deer 2 contained ^{203}Hg (90.03 ± 0.01).
f Liver contents from Mule deer 4 also contained ^{124}Sb (0.08 ± 0.04 pCi/g) and ^{125}Sb (0.7 ± 0.07 pCi/g).
g Rumen contents from Mule deer 4 also contained 124 Sb (6 ± 0.02 pCi/g), ^{125}Sb (0.6 ± 0.1 pCi/g) and ^{95}N (0.4 ± 0.1).

Table 2. Nevada Test Site Mule Deer (Strontium-90 Concentration in Hock Bones)

Year	Number of Samples	Number of Samples Greater than MDC	Range of Positive Samples pCi/g Ash	Median of Results Greater than MDC pCi/g Ash	Remarks
1982	2	2	1.3 - 1.4	1.35	
1983					No Deer Collected
1984					No Deer Collected
1985					No Deer Collected
1986	4	4	1.2 - 2.8	1.1	
1987	5	3	0.5 - 0.7	0.7	
1988	5		0.5 - 2.2	1.2	
1989	3	3	1.0 - 1.4	1.2	
1990	4	4	0.45 - 1.0	0.92	
1991	4	4	0.5 - 0.9	0.7	
1992	3	3	0.37 - 2.7	1.0	
1993	4	4	0.59 - 1.6	0.85	
1994	5	5	0.30 - 0.34	0.32	
1995	1	1			

Note: All data in the tables is reported in 2 sigma.

Table 3. Nevada Test Site Miscellanceous Wildlife (Strontium-90 Concentration in Bones)

Year	Number of Samples	Number of Samples Greater than MDC	Range of Positive Samples pCi/g Ash	Median of Results Greater than MDC pCi/g Ash	Remarks
1982					
1983					
1984					
1985					
1986					
1987	1	1	5.0	5.0	Horse Bone
1988					
1989	2	2	0.18 -0.23	0.21	Duck bone provided by N.D.W. to check for Chernobyl Fallout
1990					
1991	1	1	1.1	1.1	Lion killed area 12 NTS
1992					
1993	3	3	0.24 - 3.5	2.2	Chukar NTS
1994	1 1	1 1	0.64 0.64	0.64 0.64	Chukar NTS Chukar Esmeralda Co.
1995					

Note: All data in the tables is reported in 2 sigma.

Table 4. Nevada Test Site Bighorn Sheep (Strontium-90 Concentration in Hock Bones)

Year	Number of Samples	Number of Samples Greater than MDC	Range of Positive Samples pCi/g Ash	Median of Results Greater than MDC pCi/g Ash	Remarks
1982	18	18	0.47 - 4.3	1.55	
1983	20	20	0.8 - 4.3	1.8	
1984	24	24	0.32 - 3.2	1.26	
1985	19	19	1.0 - 9.6	2.1	
1986	19	19	0.6 - 12	1.6	
1987	20	20	5.0 - 6.7	1.8	
1988	14	14	0.06 - 1.8	0.9	
1989	16	16	0.3 - 1.7	1.1	
1990	13	13	0.5 - 2.0	1.4	
1991	16	16	0.37 - 2.7	1.0	
1992	4	4	0.67 - 1.9	1.25	
1993					No Bighorn Sheep Collected
1994					No Bighorn Sheep Collected
1995					No Bighorn Sheep Collected

Note: All data in the tables is reported in 2 sigma.

Table 5. Nevada Test Site Beef Cattle (Strontium-90 Concentration in Femur Bones)

Year	Number of Samples	Number of Samples Greater than MDC	Range of Positive Samples pCi/g Ash	Median of Results Greater than MDC pCi/g Ash	Remarks
1982	4	4	0.7 - 1.3	0.75	Medlin's Ranch (Tikaboo Valley) (Spring)
	2	2	1.8 - 2.2	2.0	NTS (Fall)
1983					Not Sampled (Spring)
	4	4	0.97 - 1.8	1.4	Medlin's Ranch (Fall)
1984	4	4	1.6 - 2.2	1.6	Nash Ranch (Hiko, NV) (Spring)
	4	4	1.4 - 1.9	1.6	Nash Ranch (Hiko, NV) (Fall)
1985	4	4	1.6 - 2.2	1.9	Nash Ranch (Hiko, NV) (Spring)
	4	4	0.14 - 2.4	1.2	Wright Ranch (Hiko, NV) (Fall)
1986	4	4	1.4 - 2.5	2.0	Agee Ranch (Rachel, NV) (Spring)
	4	0	Samples lost		Medlin's Ranch (Tikaboo Valley) (Fall)
1987	4	4	0.33 - 1.0	0.57	Sharp's Ranch (Nyala, NV) (Spring)
	5	5	0.93 - 1.3	1.3	Medlin's Ranch (Tikaboo Valley) (Fall)
1988	4	4	0.06 - 0.6	0.41	Coffer's Ranch (Beatty, NV) (Spring)
	4	4	0.16 - 0.75	0.64	Coffer's Ranch (Beatty, NV) (Fall)
1989	3	3	0.83 - 1.0	0.96	Nash Ranch (Hiko, NV) (Spring)
	4	4	0.40 - 0.76	0.43	Coffer's Ranch (Beatty, NV) (Fall)
1990	4	4	0.26 - 1.2	0.75	Agee Ranch (Rachel, NV) (Spring
	4	4	0.74 - 1.9	1.2	Medlin's Ranch (Tikaboo Valley) (Fall)
1991	4	4	0.29 - .99	0.55	Dahl Ranch (Delmar Valley) (Spring)
	4	4	0.62 - 2.4	0.66	Agee Ranch (Rachel, NV) (Fall)
1992	4	3	0.44 - 0.75	0.66	Coffer's Ranch (Beatty, NV) (Spring)
	4	4	0.34 - 0.88	0.43	Dahl Ranch (Delmar Valley) (Spring)
1993	4	4	0.29 - 0.85	0.72	Medlin's Ranch (Tikaboo Valley) (Spring)
	4	4	0.93 - 1.6	1.0	Nash Ranch (Hiko, NV) (Fall)
1994	4	3	0.16 - 0.49	0.19	Coffer's Ranch (Beatty, NV) (Spring)
	4	4	0.45 - 0.90	0.67	Sharp's Ranch (Nyala, NV) (Fall)
	1	1	1.4	1.4	NTS Bull Area 18 (Last of NTS Bull herd)

Note: All data in the tables is reported in 2 sigma.

Appendix B

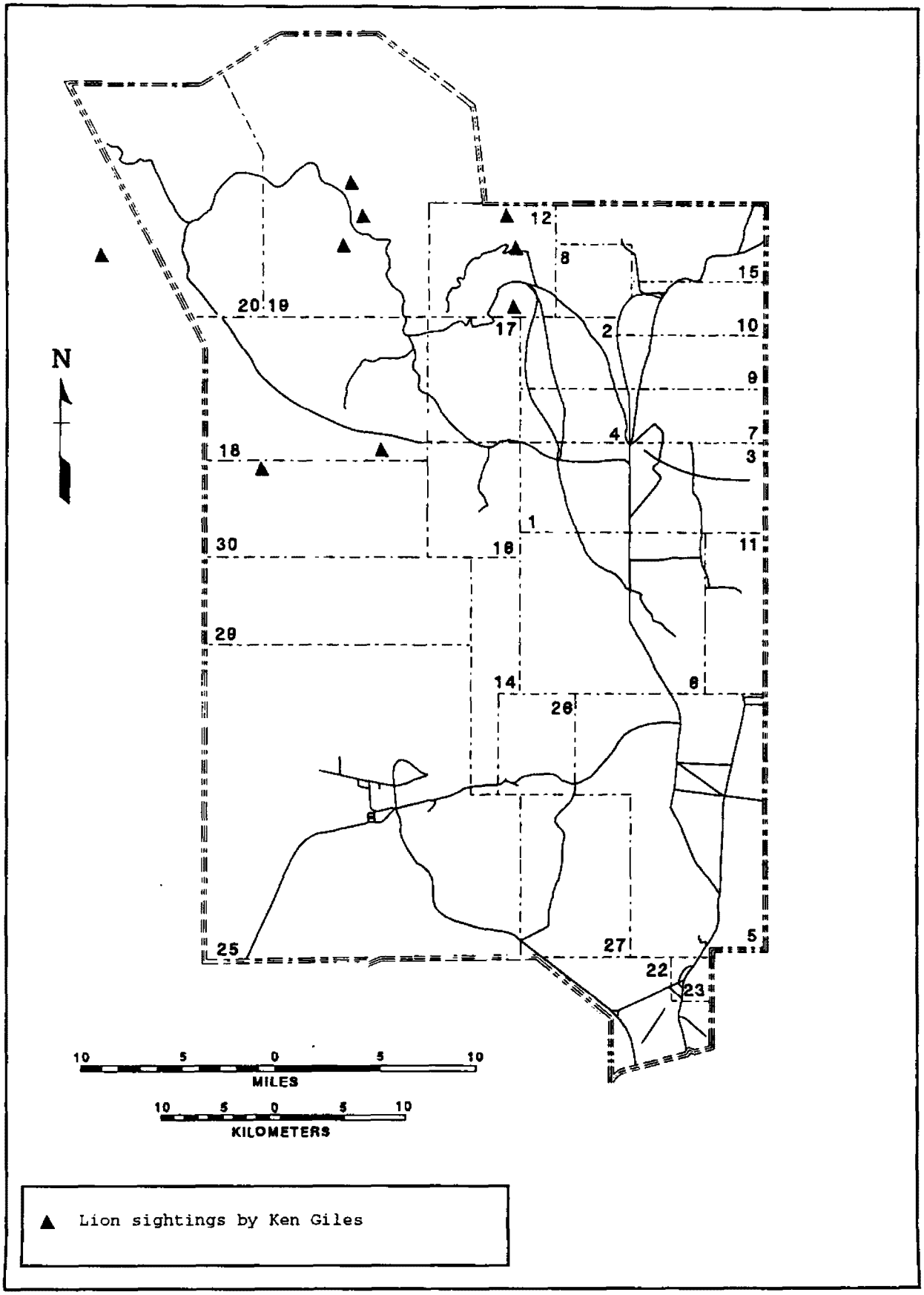

Figure 1 Mountain lion sightings on the NTS.

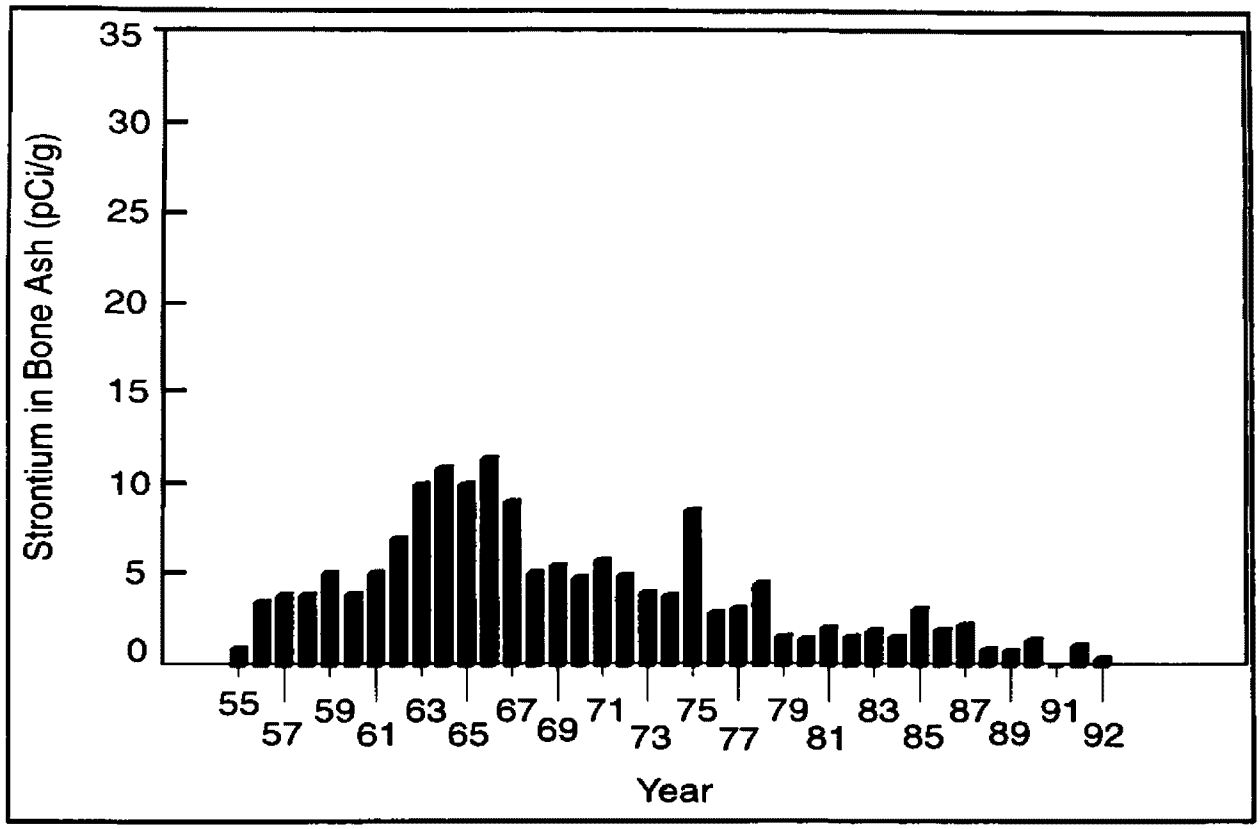

Figure 2 Average strontium-90 levels in bighorn sheep from 1955-1992.

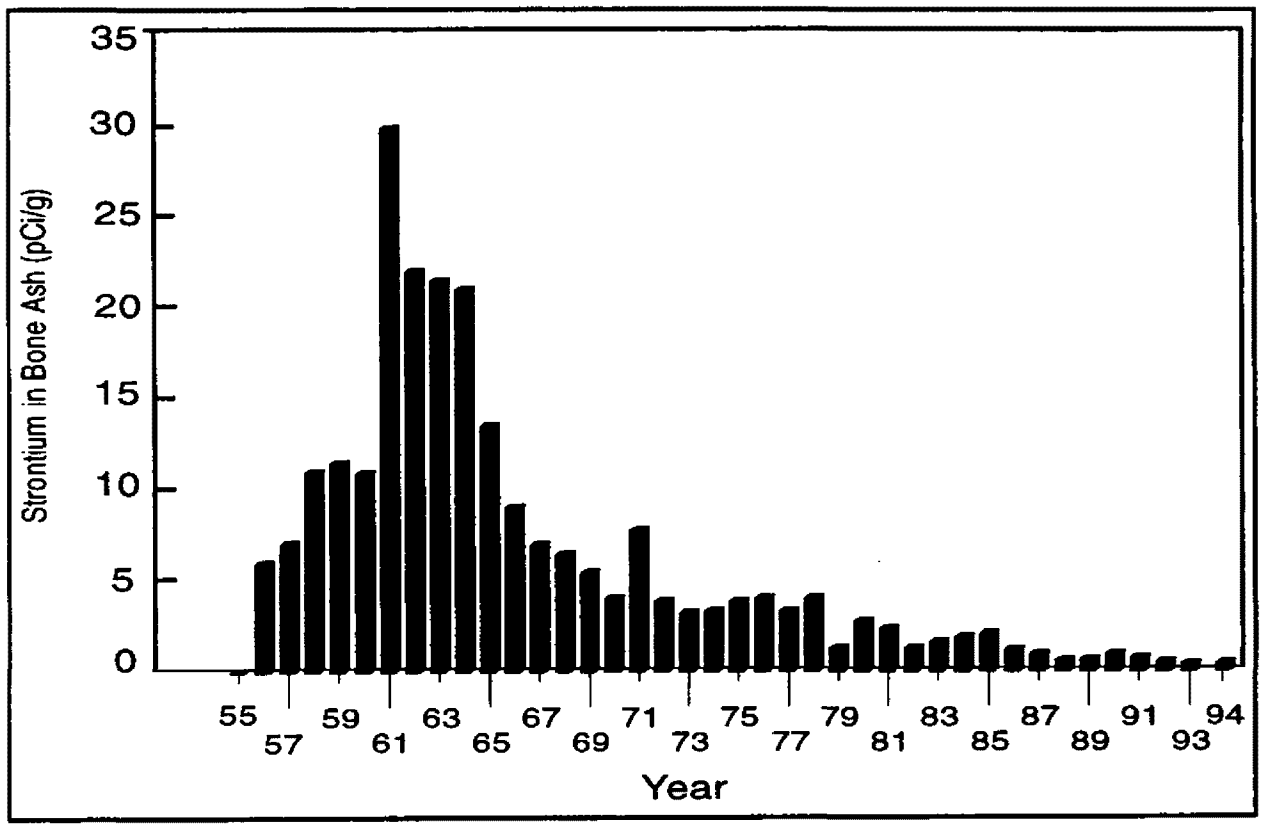

Figure 3 Average strontium-90 levels in cattle from 1955 - 1994.

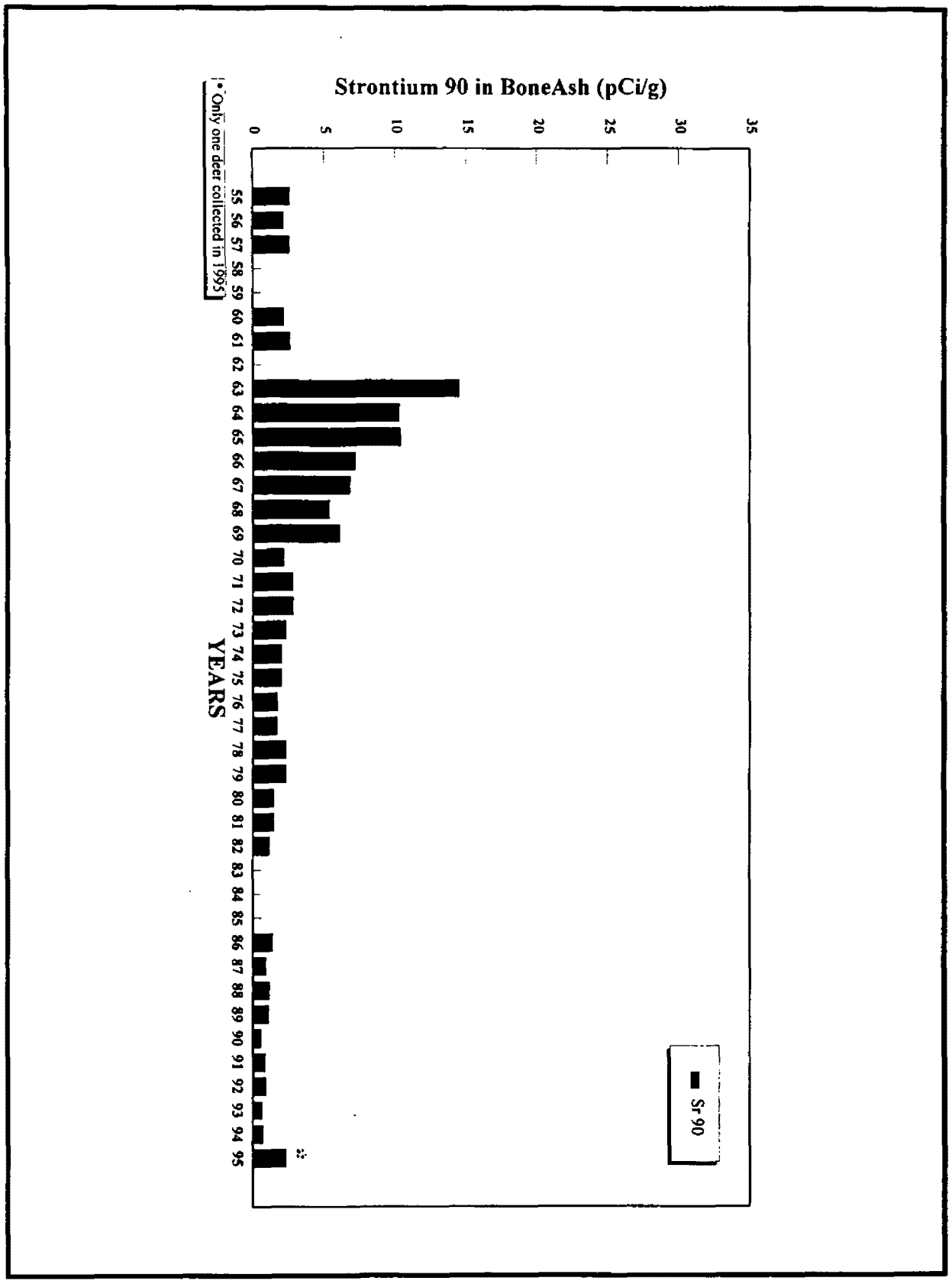

Figure 4 Average strontium-90 levels in mule deer from 1955 - 1995.

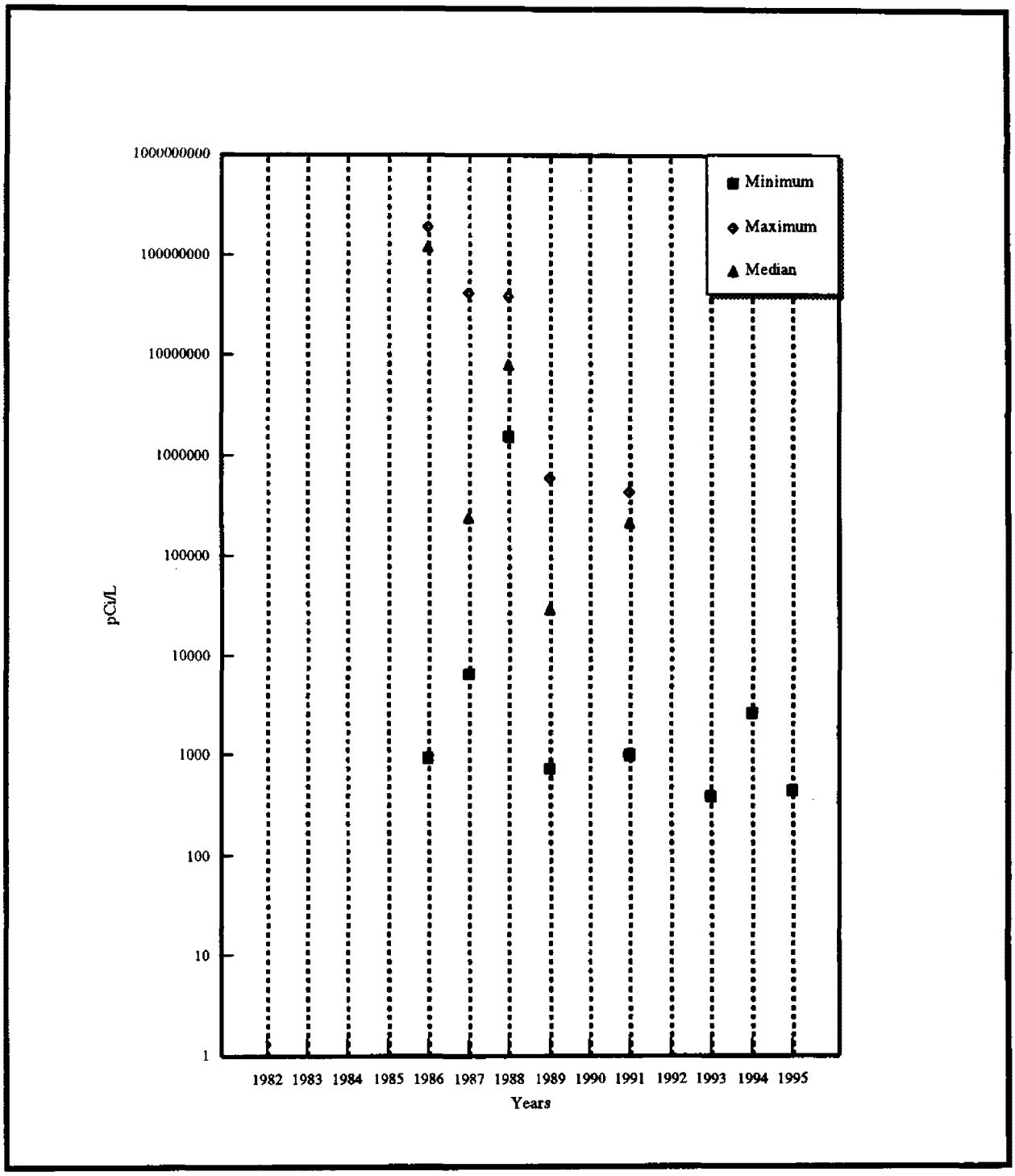

Figure 5 Tritium levels in mule deer from 1982 - 1995.

Appendix C

Announced United States Nuclear Tests

Event Name	Date	Location	Purpose
Tarko	02/28/80	NTS	Weapons Related
Norbo	03/08/80	NTS	Weapons Related
Liptauer	04/03/80	NTS	Weapons Related
Pyramid	04/16/80	NTS	Weapons Related
Colwick	04/26/80	NTS	Joint US-UK
Canfield	05/02/80	NTS	Weapons Related
Flora	05/22/80	NTS	Weapons Related
Kash	06/12/80	NTS	Weapons Related
Huron King	06/24/80	NTS	Weapons Effects
Tafi	07/25/80	NTS	Weapons Related
Verdello	07/31/80	NTS	Weapons Related
Bonarda	09/25/80	NTS	Weapons Related
Riola	09/25/80	NTS	Weapons Related
Dutchess	10/24/80	NTS	Joint US-UK
Miners Iron	10/31/80	NTS	Weapons Effects
Dauphin	11/14/80	NTS	Weapons Related
Serpa	12/17/80	NTS	Joint US-UK
Baseball	01/15/81	NTS	Weapons Related
Clairette	02/05/81	NTS	Weapons Related
Seco	02/25/81	NTS	Weapons Related
Vide	04/30/81	NTS	Weapons Related
Aligote	05/29/81	NTS	Weapons Related
Harzer	06/06/81	NTS	Weapons Related
Niza	07/10/81	NTS	Weapons Related

Continued

Pineau	07/16/81	NTS	Weapons Related
Harvarti	08/05/81	NTS	Weapons Related
Islay	08/27/81	NTS	Weapons Related
Trebbiano	09/04/81	NTS	Weapons Related
Cernada	09/24/81	NTS	Weapons Related
Paliza	10/01/81	NTS	Weapons Related
Tilci	11/11/81	NTS	Weapons Related
Rousanne	11/12/81	NTS	Joint US-UK
Akavi	12/03/81	NTS	Weapons Related
Caboc	12/16/81	NTS	Weapons Related
Jornada	01/28/82	NTS	Weapons Related
Molbo	02/12/82	NTS	Weapons Related
Hosta	02/12/82	NTS	Weapons Related
Tenaja	04/17/82	NTS	Weapons Related
Gibne	04/25/82	NTS	Joint US-UK
Kryddost	05/06/82	NTS	Weapons Related
Bouschet	05/07/82	NTS	Weapons Related
Kesti	06/16/82	NTS	Weapons Related
Nebbiolo	06/24/82	NTS	Weapons Related
Monterey	07/29/82	NTS	Weapons Related
Atrisco	08/05/82	NTS	Weapons Related
Queso	08/11/82	NTS	Weapons Related
Cerro	09/02/82	NTS	Weapons Related
Huron Landing	09/23/82	NTS	Weapons Effects
Diamond Ace	09/23/82	NTS	Weapons Effects
Frisco	09/23/82	NTS	Weapons Related
Borrego	09/29/82	NTS	Weapons Related
Seyval	11/12/82	NTS	Weapons Related

Continued

Manteca	12/10/82	NTS	Weapons Related
Coalora	02/11/83	NTS	Weapons Related
Cheedam	02/17/83	NTS	Weapons Related
Cabra	03/26/83	NTS	Weapons Related
Turquoise	04/14/83	NTS	Weapons Related
Armada	04/22/83	NTS	Joint US-UK
Crowdie	05/05/83	NTS	Weapons Related
Mini Jade	05/26/83	NTS	Weapons Effects
Fahada	05/26/83	NTS	Weapons Related
Danablu	06/09/83	NTS	Weapons Related
Laban	08/03/83	NTS	Weapons Related
Sabado	08/11/83	NTS	Weapons Related
Chancellor	09/01/83	NTS	Weapons Related
Tomme/Midnight Zephyr	09/21/83	NTS	Weapons Effects
Techado	09/22/83	NTS	Weapons Related
Romano	12/16/83	NTS	Weapons Related
Gorbea	01/31/84	NTS	Weapons Related
Midas Myth/Milagro	02/15/84	NTS	Weapons Effects
Tortugas	03/01/84	NTS	Weapons Related
Agrini	03/31/84	NTS	Weapons Related
Mundo	05/01/84	NTS	Joint US-UK
Caprock	05/31/84	NTS	Weapons Related
Duoro	06/20/84	NTS	Weapons Related
Kappeli	07/25/84	NTS	Weapons Related
Correo	08/02/84	NTS	Weapons Related
Dolcetto	08/30/84	NTS	Weapons Related
Breton	09/13/84	NTS	Weapons Related
Villita	11/10/84	NTS	Weapons Related

Continued

Egmont	12/09/84	NTS	Joint US-UK
Tierra	12/15/84	NTS	Weapons Related
Vaughn	03/15/85	NTS	Weapons Related
Cottage	03/23/85	NTS	Weapons Related
Hermosa	04/02/85	NTS	Weapons Related
Misty Rain	04/06/85	NTS	Weapons Effects
Towanda	05/02/85	NTS	Weapons Related
Salut	06/12/85	NTS	Weapons Related
Ville	06/12/85	NTS	Weapons Related
Maribo	06/26/85	NTS	Weapons Related
Serena	07/25/85	NTS	Weapons Related
Chamita	08/17/85	NTS	Weapons Related
Ponil	09/27/85	NTS	Weapons Related
Mill Yard	10/09/85	NTS	Weapons Effects
Diamond Beech	10/09/85	NTS	Weapons Effects
Roquefort	10/16/85	NTS	Weapons Related
Kinibito	12/05/85	NTS	Joint US-UK
Goldstone	12/28/85	NTS	Weapons Related
Glencoe	03/22/86	NTS	Weapons Related
Mighty Oak	04/10/86	NTS	Weapons Effects
Jefferson	04/22/86	NTS	Weapons Related
Panamint	05/21/86	NTS	Weapons Related
Tajo	06/05/86	NTS	Weapons Related
Darwin	06/25/86	NTS	Joint US-UK
Cybar	07/17/86	NTS	Weapons Related
Cornucopia	07/24/86	NTS	Weapons Related
Aleman	09/11/86	NTS	Weapons Related
Labquark	09/30/86	NTS	Weapons Related

Continued

Belmont	10/16/86	NTS	Weapons Related
Gascon	11/14/86	NTS	Weapons Related
Bodie	12/13/86	NTS	Weapons Related
Hazebrook	02/03/87	NTS	Weapons Related
Tornero	02/11/87	NTS	Weapons Related
Middle Note	03/18/87	NTS	Weapons Effects
Delamar	04/18/87	NTS	Weapons Related
Presidio	04/22/87	NTS	Weapons Related
Hardin	04/30/87	NTS	Weapons Related
Brie	06/18/87	NTS	Weapons Related
Mission Ghost	06/20/87	NTS	Weapons Effects
Panchuela	06/30/87	NTS	Weapons Related
Midland	07/16/87	NTS	Joint US-UK
Tahoka	08/13/87	NTS	Weapons Related
Lockney	09/24/87	NTS	Weapons Related
Borate	10/23/87	NTS	Weapons Related
Waco	12/01/87	NTS	Weapons Related
Mission Cyber	12/02/87	NTS	Weapons Effects
Kernville	02/15/88	NTS	Weapons Related
Abilene	04/07/88	NTS	Weapons Related
Schellbourne	05/13/88	NTS	Weapons Related
Laredo	05/21/88	NTS	Weapons Related
Comstock	06/02/88	NTS	Weapons Related
Rhyolite	06/22/88	NTS	Weapons Related
Nightingale	06/22/88	NTS	Safety Experiment
Alamo	07/07/88	NTS	Weapons Related
Kearsarge	08/17/88	NTS	Weapons Related
Bullfrog	08/30/88	NTS	Weapons Related

Continued

Dahlhart	10/13/88	NTS	Weapons Related
Misty Echo	12/10/88	NTS	Weapons Effects
Texarkana	02/10/89	NTS	Weapons Related
Kawich	02/24/89	NTS	Weapons Related
Ingot	03/09/89	NTS	Weapons Related
Palisade	05/15/89	NTS	Weapons Related
Tulia	05/26/89	NTS	Weapons Related
Contact	06/22/89	NTS	Weapons Related
Amarillo	06/27/89	NTS	Weapons Related
Disko Elm	09/14/89	NTS	Weapons Effects
Hornitos	10/31/89	NTS	Weapons Related
Muleshoe	11/15/89	NTS	Weapons Related
Barnwell	12/08/89	NTS	Joint US-UK
Whiteface	12/20/89	NTS	Weapons Related
Metropolis	03/10/90	NTS	Weapons Related
Bullion	06/13/90	NTS	Weapons Related
Austin	06/21/90	NTS	Weapons Related
Mineral Quarry	07/25/90	NTS	Weapons Effects
Sundown	09/20/90	NTS	Weapons Related
Ledoux	09/27/90	NTS	Weapons Effects
Tenabo	10/12/90	NTS	Weapons Related
Houston	11/14/90	NTS	Joint US-UK
Coso	03/08/91	NTS	Weapons Related
Bexar	04/04/91	NTS	Weapons Related
Montello	04/16/91	NTS	Weapons Related
Floydada	08/15/91	NTS	Weapons Related
Hoya	09/14/91	NTS	Weapons Related
Distant Zenith	09/19/91	NTS	Weapons Effects

Continued

Lubbock	10/18/91	NTS	Weapons Related
Bristol	11/26/91	NTS	Weapons Related
Junction	03/26/92	NTS	Joint US-UK
Diamond Fortune	04/30/92	NTS	Weapons Effects
Victoria	06/19/92	NTS	Weapons Related
Galena	06/23/92	NTS	Weapons Related
Hunters Trophy	09/18/92	NTS	Weapons Effects
Divider	09/23/92	NTS	Weapons Related